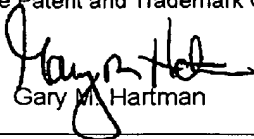


OFFICIAL

CERTIFICATE OF FACSIMILE TRANSMISSION	
I hereby certify that this paper is being facsimile transmitted to the Patent and Trademark Office on the date shown below.	
 Gary M. Hartman	Date: February 22, 2005

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No. :	09/524,227	Confirmation No. 6813
Applicant :	Irene T. Spitsberg	
Filed:	March 13, 2000	
TC/Art Unit:	1762	
Examiner :	Wesley D. Markham	
Docket No. :	13DV-13004	
Customer No. :	30952	

Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

DECLARATION UNDER 37 CFR §1.132

I, IRENE SPITSBERG, depose and say that:

- (1) I am the sole inventor of the subject matter covered by the claims pending in the above-identified patent application ("Application").
- (2) I was granted a Ph.D. in Physics of Solids and Metallurgy in 1994 from the Moscow Institute of Steel and Alloys.
- (3) I have been continuously employed as an engineer with

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

General Electric Company, GE Aircraft Engines, since 1997, and during the course of my employment have been engaged in the research and development of coating systems for components of gas turbine engines.

(4) In the last five years, I have been an inventor on twenty-six issued US patents and a named inventor for additional US patent applications, all relating to coating systems for components of gas turbine engines.

(5) In an Office Action dated October 22, 2004, claims 1-20 of the Application were rejected for a second time under 35 USC §103 as unpatentable over prior art described in the Application ("applicant's admitted prior art," or AAPA) in view of Japanese patent JP 01-180959 A to Nakamura et al. (Nakamura), either alone or in further view of one or more of U.S. Patent Nos. 4,514,469 to Loersch et al., 4,512,817 to Duhl et al., 6,042,898 to Burns et al., and 6,365,236 to Maloney.

(6) This Declaration is being submitted for the purpose of addressing arguments made in the "Response to Arguments" section of the Office Action, in which the Examiner explained why the §103 rejections were maintained in spite of arguments made in an applicant's response filed August

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

4, 2004. Passages from the Examiner's "Response to Arguments" are reproduced below, each followed by my comments.

The examiner has carefully considered the aforementioned arguments, but they are not convincing for the following reasons. The crux of the applicant's argument is that Nakamura's teachings concern improving the properties of a diffusion aluminide coating, and the problems associated with a diffusion aluminide coating do not exist in the AAPA's TBC system because the TBC system does not fail due to a failure of the diffusion aluminide bond coat. In response, this argument (i.e., that the problems associated with a diffusion aluminide coating do not exist in the AAPA's TBC system) appears to be based on speculation on the part of the applicant and is not supported by evidence of record.

Page 23, Paragraph 20, of the Office Action.

(7) Nakamura is applied by the Examiner as disclosing that thermal fatigue causes cracks to form in and propagate through a diffusion aluminide coating, which results in failure of the coating by "peeling." I am not aware of anything in the technical literature which supports Nakamura's theory that diffusion coatings fail as a result of cracks propagating through the coating (i.e., in the plane of the coating). Instead, myself and others in the technical community have observed failure of a diffusion coating as the result of rapid oxidation of the diffusion zone beneath the coating, and that rapid oxidation is the result of oxidizing agents penetrating grain boundary cracks initiated at and promoted by the columnar grain boundaries of the diffusion coating. While I

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

and others have attributed cracking of diffusion coatings on field-returned airfoils to thermal or mechanical fatigue, these cracks are observed to form along the columnar grain boundaries of the coatings (i.e., vertical (normal) to the substrate surface), and therefore do not result in peeling of the diffusion coating. These vertical cracks opened paths for oxidizing agents, resulting in oxidation and cracking of the diffusion zone beneath the diffusion coating. (The diffusion zone is prone to oxidation as a result of being enriched with oxygen-reactive elements such as Ta, W, Re, etc., depending on the composition of the substrate.) This failure process is depicted schematically in Figure 1, attached as Exhibit A. An illustrative case of such a process in a field-returned airfoil is shown in Figures 2 through 4, attached as Exhibit B. From this, I believe that the technical community does not agree with the theory that peeling of a diffusion coating is the result of crack propagation through the coating.

(8) Aside from any debate over failure mechanisms in diffusion coatings, I believe it is now generally accepted in the technical community that spallation of a TBC system employing a diffusion coating as a bond coat (i.e., a diffusion bond coat) is related to cracking of the alumina scale that forms on the surface of the diffusion bond coat (see the list of references attached as Exhibit H). Therefore, TBC spallation involves a failure mechanism that takes place

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

above the diffusion bond coat, and not within the diffusion bond coat itself. I have systematically demonstrated this failure mechanism, which is activated and enabled by the existence of mechanical stress concentrators at the "ridges" formed by the columnar grain boundaries of a diffusion bond coat, i.e., at the surface of the bond coat. These stress concentrators serve as the driving force for plastic deformation (not cracking) of the bond coat where bond coat grain boundaries intersect the bond coat surface. The localized plastic deformation imposes stresses on a TBC deposited on the bond coat, causing the TBC and/or the alumina scale to crack horizontally. This process is illustrated in Figures 5 and 6, attached as Exhibits C and D.

(9) I believe that the above evidences that at no point during the TBC spallation process does cracking of the bond coat occur, and therefore the failure mechanism that leads to TBC spallation does not relate in any way to thermal fatigue cracking of a diffusion coating (the problem addressed by Nakamura). Furthermore, I believe there is ample evidence to argue that the problems described by Nakamura as being associated with diffusion aluminide coatings do not exist in the AAPA's TBC system. I and other experts in this field have observed and concluded that deformation of the diffusion bond coat causes horizontal cracking of the TBC and/or alumina scale, both of which are

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

above the bond coat. Because bond coat cracking does not play a role in spallation of TBC deposited on a diffusion bond coat, I and others concerned with TBC spallation would not consider Nakamura's peening and recrystallization process to be relevant or useful.

The applicant's TBC system, as claimed and disclosed, comprises a diffusion aluminide bond coat. As such, one of ordinary skill in the art would have reasonably expected that problems (e.g., peeling-off, thermal fatigue, cracking and crack propagation, etc.) typically associated with diffusion aluminide coatings would be extremely relevant to diffusion aluminide bond coat-based TBC systems, such as that of the AAPA. As admitted by the applicant, Nakamura's teachings concern improving the thermal fatigue resistance, reducing crack propagation speed, and increasing the peel-off resistance of a diffusion aluminide coating. Since the TBC system of the AAPA comprises such a diffusion aluminide coating, one of ordinary skill in the art would have been highly motivated to apply Nakamura's teachings to the AAPA's TBC system.

Pages 23-24, Paragraph 20, of the Office Action.

(10) I believe that the Examiner's above conclusions are incorrect in view of the evidence that I have presented with my explanation in previous paragraphs (7)-(9). Simply stated, the technical community that has studied TBC spallation would not consider Nakamura's recrystallization process, since the benefits of Nakamura's process are intended to address problems that are not observed in TBC systems. Instead of concern for thermally-induced

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

horizontal cracking of diffusion coatings (as is Nakamura), or concern for vertical cracking and oxidation of diffusion coatings (as are others that have studied non-TBC diffusion coating failures), the concern of those that have studied TBC system spallation is the horizontal cracking of the TBC and alumina scale that lie above a diffusion bond coat.

(11) Critical to the current invention were my observations and judgment that: (a) the grain boundaries of a diffusion coating form ridges on the coating surface; (b) these ridges may have a critical aspect ratio to cause the stress concentrations to drive plastic deformation at their locations; and (c) plastic deformation is the key to the TBC spallation mechanism. None of these conclusions are suggested or can be derived from Nakamura or any of the other prior art of record. So, it seems very clear that the diffusion coating cracking mechanism of Figures 1 through 4 (Exhibits A and B) and Nakamura's shot peening process as a means of suppressing cracking of a diffusion coating would not provide any motivation to peen a diffusion bond coat to inhibit TBC spallation. It could arguably have been the case if cracking and oxidation of a diffusion bond coat was the reason for TBC spallation. But it is not, as far as I am aware from the available literature (Exhibit H) and based on my observations (e.g., Exhibits C and D).

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

(12) It can be further stated that my goal of using peening was to achieve a certain degree of bond coat surface planarity. As such, it was not apparent or even predictable as to the surface geometry of the grain boundary ridges that would result from peening and recrystallization. It was only through experimenting that peening was found to be suitable and capable of altering the grain boundary ridges to produce a surface geometry that inhibits TBC spallation. So, it can be seen that peening was applied for a specific and unique purpose (as opposed to a generic purpose), this purpose was different from Nakamura's purpose of abating mechanical fatigue, and the effect of my peening technique was not predictable.

Additionally, the examiner notes that the applicant's position and argument that, in the TBC-system of the AAPA, the TBC spalls as a result of cracks within an alumina scale that grows on the bond coat and/or at the interface between the bond coat and alumina scale, not as a result of cracks propagating through the diffusion aluminide bond coat, does not appear to be entirely accurate. In the sentence bridging pages 2 and 3 of the applicant's specification, the applicant states that, "...TBC deposited on diffusion aluminide bond coats typically spall at the alumina-to-bond coat interface or within the alumina layer itself". This statement clearly indicates that, in some cases, the TBC deposited on diffusion aluminide bond coats spalls at other locations. As such, one of ordinary skill in the art would have looked to improve the properties of each layer/coating in the TBC system of the AAPA to reduce the chances that failure would occur at any point in the system. (Original emphasis.)

Page 24, Paragraph 20, of the Office Action.

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

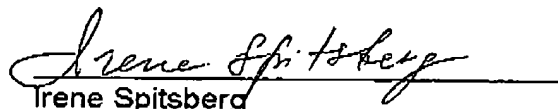
(13) The statement cited by the Examiner from the Application that the TBC can spall at "other locations" was unfortunately too generic, and therefore open to misinterpretation. As I have stated here, it is generally accepted that TBC spallation on a diffusion bond coat occurs as a result of horizontal cracks developing in the TBC and/or the alumina scale. As reported in the references listed in Exhibit H, three known scenarios are for cracks to develop at (a) the TBC-alumina scale interface, (b) the alumina scale-bond coat interface, and/or (c) a combination of the two, in which case a crack propagates through the TBC and the alumina scale. Examples of these three crack propagation paths are shown in Figures 5 through 15 (Exhibits E, F, and G). The particular crack propagation path appears to depend on the surface preparation and coating processes used, but all generally have the same detrimental effect on TBC life. Regardless of the crack path, the driving force for the cracks is still the same - stress concentration at the bond coat surface ridges.

(14) The motivation to "improve the properties of each layer/coating," as stated by the examiner, is not clear to me. One must first specify which properties must be improved, and then consider whether "improving" a property of one layer could have an unintended negative effect on

Application No. 09/524,227
Docket No. 13DV-13004
Amendment dated February 22, 2005
Reply to Office Action of October 22, 2004

a second layer. Where the motivation is to improve properties that affect TBC performance, numerous properties of the individual TBC layers (e.g., the thermal conductivity of the bond coat) would not appear to have any affect. From my explanation here, it is apparent that thermal fatigue resistance of a diffusion coating (Nakamura, who does not appear to address diffusion coatings used as bond coats) is another property that would not appear to have any affect on TBC performance. Therefore, Nakamura would not have provided me with any motivation to peen a diffusion bond coat to improve TBC performance.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.


Irene Spitsberg

Attachments: Exhibits A through H